

Teaching sustainability in artisanal and small-scale gold mining

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The mining industry as a source of raw materials is essential to society, yet it lacks a good reputation due to the type of management that has historically been applied to many of its social and environmental impacts. It is argued that this situation has hindered many mining projects around the world from obtaining a social licence to operate. The latter considerations are very common in Latin American countries. As a result, the mining sector has realised that long-term business viability is associated with more profits for shareholders, but also with activities that improve the livelihoods of local communities, increasing the capacity of local governments and preserving the ecosystems around the projects. However, recent studies have shown that most of the current progress in incorporating sustainability concepts in mining has focused mainly on monitoring and preventing the environmental and social impacts of extractive activities. Thus, contributing to the development of the territories around mining projects is a key aspect of business competitiveness by reducing the costs and risks of stopping projects, innovating new ways of relating with stakeholders and improving the industry's level of reputation as well as its position in the market. However, this contribution requires formal strategies and models that allow companies and communities to understand the different resources of the territories where their mining activities are developed, and these resource transformations, in order to establish the best way to articulate the project with the territory, seeking an effective contribution to its development, truly sustainable in time even after mine closure.

All these aspects should be considered when training new professionals, who should receive adequate education on sustainability issues so that they can support the communities engaged in this practice.

INTRODUCTION AND BACKGROUND

In research titled 'Sustainability of small-scale artisanal gold mining in Northeastern Antioquia' (Perea, C., Restrepo, O. 2015), the principles that exist for a sustainable society were presented, including those designed for industries such as mining to include these objectives. Based on these principles, a reading of the current situation of small-scale artisanal gold mining in Northeastern Antioquia was made.

Likewise, it was shown that in the northeast of Antioquia it is possible to work towards the sustainability of small-scale artisanal gold mining, a situation that was evidenced in the reduction of the systematic increases in the concentration of substances in the earth's crust, as well as in the reduction of the concentration of substances produced by the mining activity. In this same research, it was highlighted that all this has been achieved without talking about sustainability, without having an operational plan or a roadmap to dictate the steps to be followed by this industry.

Therefore, it is necessary to continue working to change certain needs that still persist in all areas of sustainability. For example, in the environmental dimension, although the use of mercury has been reduced, it is still overused by small-scale artisanal gold mining in Northeastern Antioquia. This prevents progress in other very important aspects of sustainability, such as the elimination of structural barriers that affect people's health.

Similarly, it was observed that in the economic sphere, work has also been done on sustainability through changes in processes the introduction of gold concentration equipment that maximises the benefits of mining operations. However, complete amalgamation of the ore still persists, a process that prevents further progress in the sustainability of this sector.

Finally, socio-cultural needs are also of great importance in achieving the principles of a sustainable society. As noted, it is possible to generate more added value if sufficient time is invested in concentrating the ore extracted from the mine, as in Canada, where this process has become part of their culture. Thus, just as concentrator equipment and an equipment to recover the gases (retorts) have become part of the culture, work can continue to change the entire method to one without mercury.

Considering the above, the objective of this research was to design an operational plan that will serve as a guide to contribute to the sustainability of small-scale artisanal gold mining in Northeastern Antioquia, based on the needs identified.

DISCUSSION

Through the presentation of the theories of sustainability, three common factors were identified within the different positions proposed, which are the environmental, economic and socio-cultural dimensions. With these, different needs were recognised in small-scale artisanal gold mining in Northeastern Antioquia that still require action. This facilitated the development of an operational plan that, through actions or activities to be implemented, will contribute to the sustainability of this sector.

During the development of the research, it was possible to observe the implementation of the term backcasting (also consulted through bibliographic sources), as follows:

- Step A was applied when the problem of mercury contamination, problems such as child labour or the little added value given to gold in Northeastern Antioquia were identified or recognised.
- Step B was followed when a contrast was made between the needs and different sustainability principles identified.
- Step C was applied by proposing ideal scenarios for small-scale artisanal gold mining in Northeastern Antioquia, such as the use of equipment that allows transforming gold without the use of mercury.

All of the above was done to reach step D, which consists of the elaboration of the plan, and which responds to the questions 'what should be done?' and 'when should things be done?', through the action or activity matrix and the chronogram matrix.

It was also observed how the seven questions of the Mining, Minerals and Sustainable Development (MMSD) were used, not only to evaluate the activities proposed in the operational plan, but also as part of the matrices to guide and plan the activities to be implemented. In this way, the MMSD proposal can not only be used to confirm that mining can be included in sustainability, but can also be used as a starting point for the design of plans that contribute to sustainability.

CONCLUSIONS

Proposals such as the correct identification of the mineral composition and the correct choice of the gold beneficiation circuit will contribute to the reduction of the concentration of substances in the earth's crust. Likewise, with the implementation of cyanide elimination methods, it will contribute to the

reduction of the concentration of substances produced by society. In addition, knowing the project inventory (through exploration), progress will be made in securing resources, and thus with all the proposed activities, the structure of this operating plan is valued because it is based not only on theoretical principles of sustainability in mining, but also on specific principles raised from these and, in addition, it is organised by stages of the mining cycle that ensure an organisation in time and investment of the steps to be developed.

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